

A Miocene pseudodontorn (Pelecaniformes : Pelagornithidae) from the Ichishi Group of Misato, Mie Prefecture, Central Japan

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Abstract. Part of a right dentary of a pseudodontorn, bony-toothed bird, was newly found from the shell bed of the Kamimitsugano tuffaceous siltstone Facies of the Mitsugano Member in the Oi Formation (17.5–17 Ma), Ichishi Group in the Misato area, Mie Pref., Central Japan. This is the first record of a pseudodontorn bill from the Miocene of Japan. The discovery supplements the fossil record of pseudodontorns in Japan, which comprises the Early Oligocene to the Pliocene. The arrangement of the bony teeth corresponds to that of *Osteodontornis orri* Howard, 1957 known from the west coast of North America, and the specimen is provisionally identified as *Osteodontornis* sp.

Key words : Aves, Ichishi Group, Japan, Miocene, *Osteodontornis*, pseudodontorn

Introduction

The Miocene Ichishi Group, distributed in the Ichishi region of Mie Prefecture, Central Japan (e.g., Shibata, 1967), is famous for the abundant occurrence of fossils (Figure 1A). In particular, the shell beds in the Kamimitsugano tuffaceous siltstone facies of the Mitsugano Member in the Oi Formation (Shibata, 1967) yield a variety of vertebrate remains including sharks (Uyeno *et al.*, 1980), a bird (Diomedidae; Davis, 1996) and marine mammals. These are recognized as important sources for Japanese Miocene fossil vertebrates.

A large dentary found by Fujio Sakakura from the outcrop in Misato area (Figure 1B) was first identified as that of a fish, but turned out to be the right dentary of a bony-toothed bird after chemical preparation with acetic acid by Fumio Ohe. This is the first and only example in which the arrangement of the bony teeth is preserved in the Miocene record of pseudodontorns from Japan. The bony tooth-like prominences borne by the tomia is a remarkable feature of pseudodontorns, and their arrangement is important for the taxonomy of this group. This paper aims to describe the Ichishi specimen in order to further the taxonomical evaluation of Japanese pseudodontorns and palaeo-geographical studies of the marine avifauna in the Pacific rim.

Systematic paleontology

Order Pelecaniformes Sharpe, 1891
Family Pelagornithidae Furbringer, 1888
Genus *Osteodontornis* Howard, 1957

Osteodontornis sp.

Figures 2, 3

Material.—A partial right dentary with bony teeth. Mizunami Fossil Museum, MFM28351, collected by Fujio Sakakura on February 13, 1994 (=the Ichishi specimen).

Locality.—Misato, Misato Village, Mie Prefecture, Japan (Figure 1).

Horizon and age.—Shell bed in the Kamimitsugano tuffaceous siltstone facies of the tuffaceous sandstone and shale Mitsugano Member, Oi Formation, Ichishi Group (Shibata, 1967). Late Early Miocene. 17.5–17 Ma. (Itoigawa and Shibata, 1992).

Description.—The specimen consists of part of a right dentary, missing both anterior and posterior ends (Figures 2, 3). Anteriorly, the mandible is slender and slightly curves dorsally. The bony teeth, sharp and conical prominences, stand vertically on the dorsal margin, which inclines somewhat to the external side, so that the vestibular margin of the bony teeth is continuous with the external surface of the mandible.

The bony teeth can be differentiated on the basis of size,

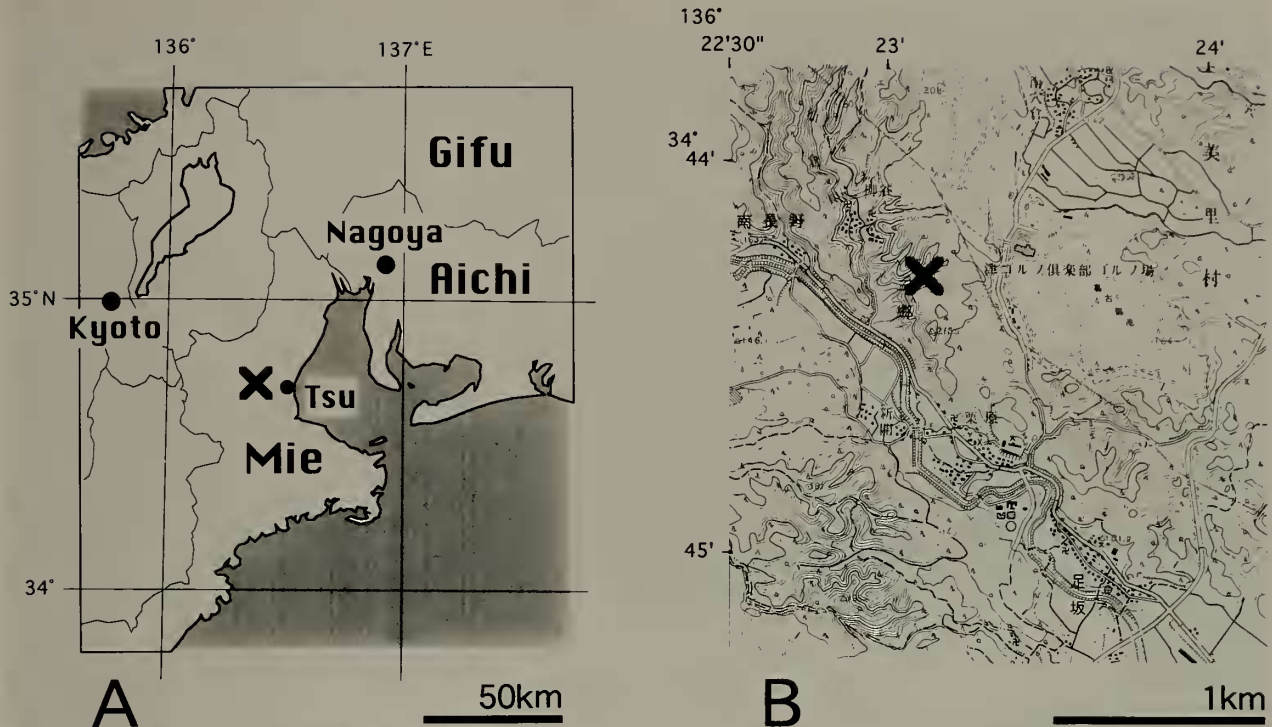


Figure 1. Locality maps for the pseudodontornis from Ichishi. **A.** The locality map in Central Japan. The locality is about 10 km west of the center of Tsu City, Mie Pref. **B.** The locality map showing Misato of Misato Village, based on the 1:25,000 scale topographic map of the Geographical Survey Institute of Japan, "Tsu-seibu".

into four types; four large teeth (L1-L4), three medium teeth (M1-M3), five small teeth, and at least eight tiny processes (Figure 3). These size classes exhibit a repetitive pattern; about midway between each pair of large teeth is a medium tooth, the pair of spaces between these two sizes each contains a small tooth, and, finally, a tiny process occupies the intervening space between each of these teeth (Figures 2, 3). A deep and round hole (h) occurs in front of the third large tooth (Figures 3 upper and lower). The distance between each of the large teeth increases anteriorly.

The external surface is almost flat and bears a deep, plain longitudinal sulcus, the mandibular groove (mg), that draws nearer to the ventral margin anteriorly (Figures 2A, 3 upper and lower). The internal surface is smoothly convex and a shallow sulcus with some nutrient foramina runs just above the ventral margin (Figures 2B, 3 middle).

Broken sections show that the mandible and the bony teeth are completely hollow and the inner surface of the bone wall is rough. The thickness of the bone wall is, at most, 2 mm.

Measurements.—See Table 1.

Comparison and remarks.—The pattern of size variation in the bony teeth of the Ichishi specimen is similar to that of *Osteodontornis orri* Howard, 1957 known from the Upper Miocene of California (Howard, 1957, Howard and White, 1962, reconstruction in Harrison and Walker, 1976), and also of the referred portion of a lower mandible of *Pseudodontornis longirostris* (Spulski, 1910), described from the Upper

Oligocene (Olson, 1985) of South Carolina (figure 1A of Hopson, 1964—the South Carolina specimen).

If we compare the Ichishi specimen with *Osteodontornis* and the South Carolina specimen, the relatively smaller sizes of bony teeth, which are diagnostic for the classification of pseudodontornis, link the Ichishi specimen to *Osteodontornis*. The South Carolina specimen, in which the heights of the large bony teeth are almost equivalent to the rest depth (height) of the mandible not including the bony teeth, has by far the largest and most robust bony teeth in comparison with the Ichishi specimen or *Osteodontornis*. Therefore, the Ichishi specimen is likely to be assigned to *Osteodontornis* species. In addition, the zoogeographical similarity of the Miocene of Japan and California, and the dissimilarity between the Pacific and the Atlantic, support this identification.

Compared with *Osteodontornis orri* Howard, 1957, the increasing rate of separation within each size variation pattern of the bony teeth in the Ichishi specimen corresponds exactly to part of the lower mandible of the former (Figure 4A), and the restored head of this animal, in its original state, is shown in Figure 4B. This indicates that the size of the Ichishi specimen is about two-thirds of the type specimen of *O. orri*. In addition, there is a gap of some millions of years between the older Ichishi specimen and the younger *O. orri*. In conclusion, we assume the Ichishi specimen is a species of *Osteodontornis*, but may not be the same species as *O. orri*.

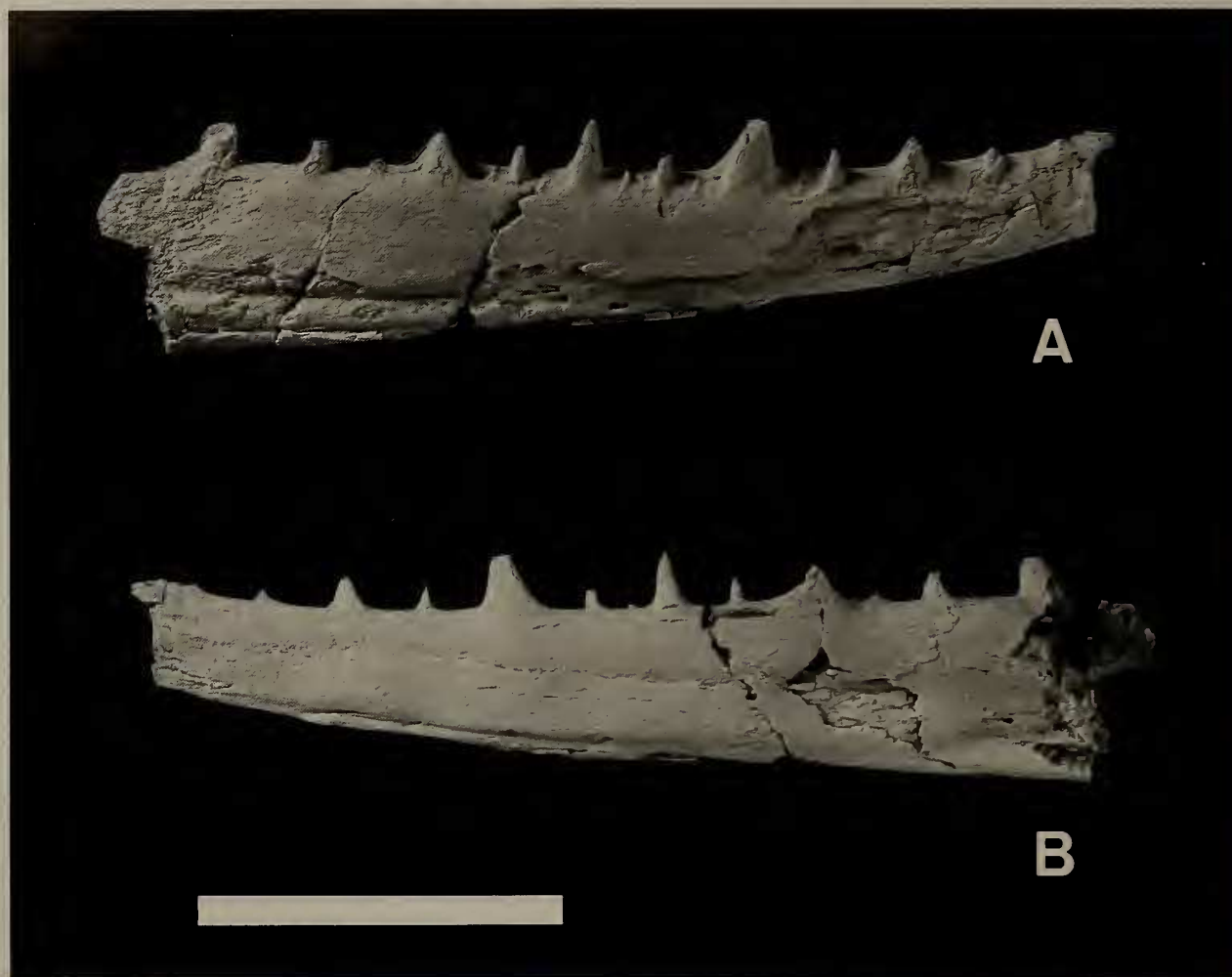


Figure 2. *Osteodontornis* sp., the Ichishi specimen, partial right dentary, MFM28351. A. The external surface. B. The internal surface. The scale bar is 50 mm long.

On the other hand, the confused taxonomy of pseudodontorns produces vexatious problems. Olson (1985) pointed out the possibility of synonymising *Osteodontornis* Howard with the earlier name *Cyphornis* Cope. All names of pseudodontorns, except the oldest name *Pelagornis* Lartet, may suffer from a similar problem, and this group is in need of comprehensive and sensible revision (Olson, 1985). So, we assign the Ichishi specimen to *Osteodontornis* sp., but emphasize that this is very provisional.

A brief review of pseudodontorn records from Japan

Several remains of pseudodontorns have been recorded from the marine Tertiary System of the Japanese Archipelago (Figure 5).

The oldest fossil is a rostrum tip that was excavated from the Lower Oligocene Iwaki Formation in Iwaki City, Fukushima Pref. (1 in Figure 5; Hasegawa *et al.*, 1986; Ono and Hasegawa, 1991). In addition to the pseudodontorn, the

Iwaki Formation has also yielded *Puffinus*, *Morus*, *Sula*, *Phalacrocorax*, plotopterids, accipitrids and alcids (Ono and Hasegawa, 1991). Though the taxonomic study of the Iwaki specimen is still under preparation, the cyclic pattern of the teeth, which consists of large (posterior) and medium and small (anterior) bony teeth, is different from that of *Osteodontornis orri*, as determinable from the published picture. Thus, the Iwaki specimen and the Ichishi specimen (*Osteodontornis* sp.) may represent different taxa.

Okazaki (1989) reported a slab bearing a humerus and some fragmentary wing elements from the Upper Oligocene Yamaga Formation, Ashiya Group, in Kitakyushu City, Fukuoka Pref. (2 in Figure 5). The locality of this specimen is only 1 km northwest of the locality of the "Orio specimen" (Hasegawa and Seki, 1979) of *Copepteryx hexeris* Olson and Hasegawa, 1996 (Plotopteridae).

Two records, other than the present report, are from the Miocene formations. Each of the three deposits is of similar age: middle Miocene. Ono (1989) described a

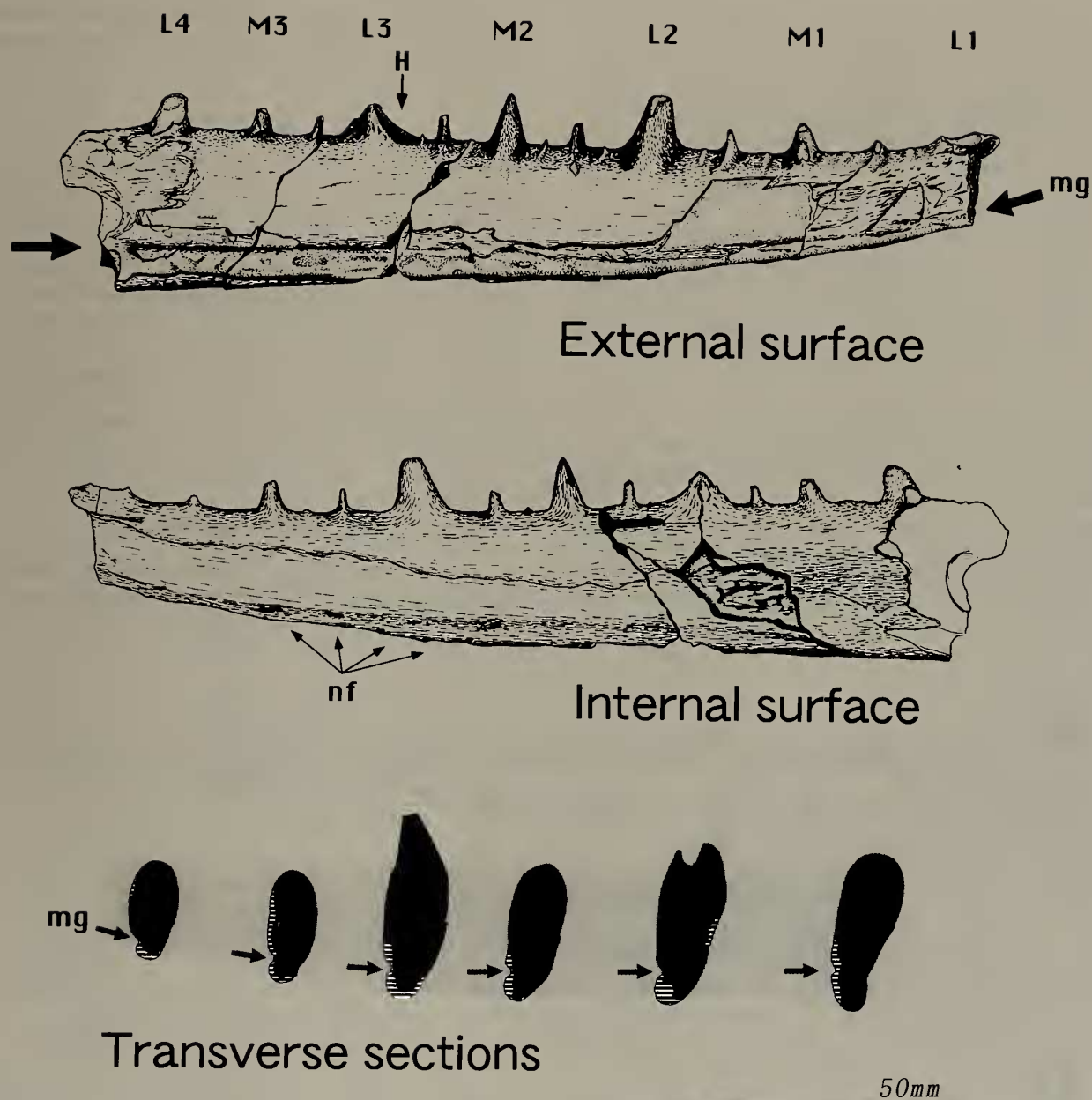


Figure 3. *Osteodontornis* sp. from Ichishi, MFM28351. External (upper), internal (middle) and transverse (lower) views from top to bottom respectively. Abbreviations: h, hole; L1-4 and M1-3, the 1st to 4th large bony tooth and the 1st to 3rd medium bony tooth respectively; mg, mandibular groove. The scale bar is 50 mm long.

pseudodontorn quadrate from the early Middle Miocene Nagura Formation, Chichibumachi Group of the Chichibu City, Saitama Pref. (5 in Figure 5), and identified it as *Osteodontornis* sp. Ono's identification was "very tentative" as he noted, but the occurrence of the Ichishi specimen may support his conclusion. The Nagura Formation has also yielded *Puffinus* and *Sula* besides the pseudodontorn (Ono and Sakamoto, 1991).

Ono (1989) mentioned pseudodontorn material from Mizunami (3 in Figure 5). Mizunami is one of the neighbor-

ing sedimentary basins to Ichishi, however, a detailed description of this material has not been published. The youngest known pterosaur, *Platyoxyrion* sp., was reported from the Mizunami group (Olson and Hasegawa, 1985).

The youngest pseudodontorns are Pliocene in age (Unwin, 1993), and their fossil record is thin (Olson, 1985). Two Pliocene records are known from Japan. Ono *et al.* (1985) reported on a humerus from the Lower Pliocene of Maesawa Town, Iwate Pref. (1 in Figure 5). It is very important as it is a certain record of Pliocene pseudodontorns.

Table 1. Measurement of MFM28351 (the Ichishi specimen) in mm.

Maximum length of the specimen	139.7
Maximum height of the mandible plus bony tooth	31.2+
Maximum height of the mandible not including the bony teeth	25.3
Minimum height of the mandible not including the bony teeth	14.2+
Maximum width of the mandible	10.1
Height of the mandible at the point of the 2nd large tooth	26.9+
Height of the largest bony tooth (2nd large tooth)	7.7+
Distance	
between the 1st large tooth and the 1st medium tooth	23.6
between the 1st medium tooth and the 2nd large tooth	22.2
between the 2nd large tooth and the 2nd medium tooth	22.2
between the 2nd medium tooth and the 3rd large tooth	20.3
between the 3rd large tooth and the 3rd medium tooth	16.6
between the 3rd medium tooth and the 4th large tooth	13.7

Ono *et al.* (1985) also referred a femur from the Upper Pliocene Dainichi Formation, Kakegawa Group of Shizuoka Pref. (7 in Figure 5), which was previously identified by Ono (1980) as "Diomedeidae, gen. et sp. indet.", to a pseudodontorn. Ono *et al.* (1985) compared the Kakegawa specimen with *Pseudodontornis stirtoni* of the Pliocene (Howard and Water, 1969); Harrison and Walker (1976) subsequently erected a new genus and species for this speci-

men: *Neodontornis stirtoni*. If the Kakegawa specimen is indeed a pseudodontorn, it is one of the youngest records of the family in the world.

Conclusion

The Ichishi specimen has the most diagnostic feature of Pelagornithidae, and was identified as a species of *Osteodontornis*. It supports evidence of the similarity of marine avifaunas of Japan and the west coast of North America. The pseudodontorn records of Japan range from the Early Oligocene to the Late Pliocene. Because of their stratigraphically continuous record, Japanese pseudodontorns form important materials for the zoogeographical and systematic study of this family. The Tertiary System of Japan, during which there was extensive development of marine deposits, is indispensable for the study of the evolution and palaeo-ecosystem of marine members of higher vertebrates.

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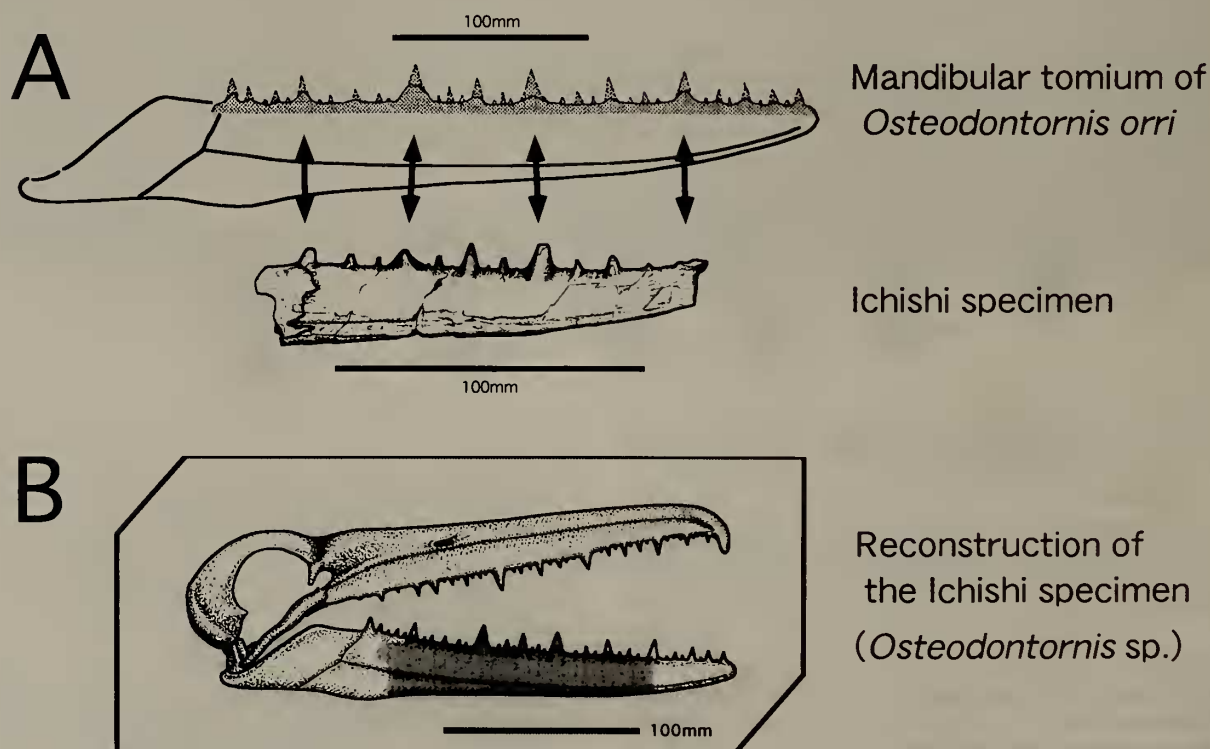


Figure 4. Restoration of *Osteodontornis* sp. from Ichishi. All scale bars represent a length of 100 mm. **A.** Correspondence between the arrangement of the bony teeth in the Ichishi specimen (below) and *Osteodontornis orri* Howard, 1957 (above: from Harrison and Walker, 1976). **B.** The original state of the Ichishi specimen. Both heads, of the Ichishi pseudodontorn (B) and *Osteodontornis orri* (A-above), are scaled by the shorter scale bar, and only the Ichishi specimen (A-below) is scaled by the longer scale bar. Note the size reduction necessary for *Osteodontornis orri* to match the Ichishi specimen, which implies a smaller size for the Ichishi pseudodontorn.



No. in map	Age	Locality	Horizon	Element	Reference
1	E. Oligocene	Ogawa-tyo, Iwaki, Fukushima.	Iwaki F., Shiramizu G.	Rostrum	Hasegawa et al., 1986 Ono and Hasegawa, 1991
2	L. Oligocene	Yoshida, Mizumaki, Fukuoka.	Yamaga F., Ashiya G.	Humerus (left)	Okazaki, 1989
3	late E. Miocene	Mizunami, Gifu.	Mizunami G.	- No report -	(Ono, 1989)
4	late E. Miocene	Sangou, Misato, Mie.	Oi F., Ichishi G.	Dentary (right)	Present report
5	early M. Miocene	Ohnohara, Chichibu, Saitama.	Nagura F., Chichibumachi G.	Quadrate (right)	Ono, 1989
6	E. Pliocene	Seibo, Maesawa, Iwate.	Yushima F. (=Tatsunokuchi F.)	Humerus (right)	Ono et al., 1985
7	L. Pliocene	Haranoya, Kakegawa, Shizuoka.	Dainichi F., Kakegawa G.	Femur (right)	Ono, 1980 Ono et al., 1985

Figure 5. Summary of pseudodontorn records of Japan. Locality numbers in above figure correspond to material listed in below in order of geological age. Abbreviations: E, Early; M, Middle; L, Late; F, Formation; G, Group.

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